(b) introducing a signal light modulated at a frequency f_s into said optical loop;

(c) adjusting the optical path length of said optical loop so that said frequency f_s becomes equal to an integral multiple of the reciprocal of a recirculation period of said optical loop; and

(d) regenerating an optical clock by mode-locking said laser oscillation according to said signal light,

wherein amplitude modulation is performed in said nonlinear optical medium by four-wave mixing using said signal light as pump light.

A marked-up version of the claims is included in the Attachment.

Please add the following new claim:

18. (NEW) An optical device according to claim 7, wherein said nonlinear optical medium has a zero-dispersion wavelength substantially equal to the wavelength of said signal light.

II. REMARKS

A. Introduction

In the Office Action, the written description, drawings and abstract have been objected to, and all claims are rejected based on prior art.

In this Response, the Specification is amended to address the objections, claims 4 and 5 are canceled, claims 1, 8, 14, 15 and 17 are amended, new claim 18 is added, and remarks are provided. Claim 8 is amended and new claim 18 is added to re-introduce the dependencies of original claim 8.

B. Rejection of Claims 1-3, 5, 9, and 11-17 Under 35 U.S.C. § 102

These claims are rejected as being anticipated by Bigo et al.(10/97).

As noted above, rejected claim 5 is canceled herein. Nevertheless, for the following reasons, it is respectfully submitted that the present invention, as recited by amended claims 1-3, 9 and 11-17, was not anticipated or rendered obvious by the cited reference.

It is noted that claim 4 was not rejected as being anticipated based upon this reference. The following subject matter of claim 4, i.e., "amplitude modulation is performed in said non-linear optical medium by four-wave mixing using said signal light as pump light", has been added

to each independent claim. As the Action appears to already admit that this Bigo et al. reference fails to disclose at least this feature, it is respectfully submitted that independent claims 1, 14, 15 and 17 cannot be anticipated by Bigo et al.

In addition, Bigo et al. appears to disclose an optical device in Fig. 9, which comprises: an optical path provided between an input port (data input in Fig. 9), to which signal light modulated at a frequency fs is supplied, and an output port (clock output in Fig. 9); and an optical loop optically coupled to the optical path. The optical loop comprises: an optical amplifier (EDFA in Fig. 9) for compensating for a loss in the optical loop so that laser oscillation occurs in the optical loop; an adjuster (optical delay line in Fig. 9) for adjusting an optical path length of the optical loop so that the round-trip delay is precisely tuned to a multiple of the signal bit rate (pg. 1215 col. 1, lines 1-5); and an SOA (semiconductor optical amplifier) for injection-locking the laser oscillation (pp. 1214, Col. 2, lines 42-58 and 1215, lines 1-20).

However, Bigo et al. fails to disclose at least an optical fiber as a nonlinear optical medium for mode-locking the laser oscillation according to the signal light, and amplitude modulation performed in the nonlinear optical medium by four-wave mixing using the signal light as pump light, as recited in independent claims 1, 14, 15 and 17.

Rather, Bigo et al. discloses, as noted above, an SOA for injection-locking the laser oscillation. Injection-locking is distinctly different from the mode-locking through four-wave mixing performed in the optical fiber as a nonlinear optical medium, as recited herein. Thus, Bigo et al. merely teaches another device for all-optical clock recovery, but not the presently recited device/system.

C. Rejection of Claims 4, 6-8 and 10 Under 35 U.S.C. §103

These claims are rejected as being made obvious by this same Bigo et al. reference, alone or in combination with Smith et al. or Pastel.

Claim 4 has been canceled, as noted above. Nevertheless, it is respectfully submitted that the present invention, as recited by claims 6, 7, 8 and 10, was not rendered obvious by the cited references, either alone or in combination.

The comments above regarding Bigo et al. (10/97) are expressly incorporated herein, as they relate to amended independent claim 1, from which each of the rejected claims ultimately depend. Further, it is respectfully submitted that neither Smith et al. nor Pastel suggests modification of Bigo et al. to include the optical fiber and amplitude modulation recited in claim 1.

III. CONCLUSION

Withdrawal of the foregoing rejections is respectfully requested.

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

Date: 7/28/03

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

A. IN THE ABSTRACT

Please amend the Abstract as follows:

[The present invention relates to a] An optical device for regenerating an optical clock[. The optical device includes], including an optical path provided between an input port to which signal light modulated at a frequency f_s is supplied and an output port, and an optical loop optically coupled to the optical path. The optical loop includes an optical amplifier for compensating for a loss in the optical loop so that laser oscillation occurs in the optical loop, an adjuster for adjusting the optical path length of the optical loop so that the frequency f_s becomes equal to an integral multiple of the reciprocal of a recirculation period of the optical loop, and a nonlinear optical medium for mode-locking the laser oscillation according to the signal light. [For example, in the nonlinear optical medium, four-wave mixing using the signal light as pump light is generated by third order nonlinear effects to perform amplitude modulation and regenerate an optical clock at the wavelength of the laser oscillation.]

IN THE SPECIFICATION:

Please AMEND the paragraph beginning on page 9, second full paragraph extending over to page 10, as follows:

Particularly in this preferred embodiment, the nonlinear medium 16 is provided by a third-order nonlinear medium. Without a signal input, a continuous wave at wavelength of λ_c is lased from the optical loop 8. When the signal light is introduced into the nonlinear medium 16, the [rasing] lasing wave (CW) is amplitude-modulated (AM) or frequency-modulated (FM) in the nonlinear medium 16, and then mode-locked to the frequency of f_s. As a result, clock pulses (optical clock) having a wavelength λ_c and a frequency f_s are generated or regenerated, and the clock pulses are output through the optical coupler 10 from the output port 4. This will now be described more specifically.

Please amend page 21, second full paragraph extending over to page 22, as follows:

In the system shown in FIG. 5, the waveform of the signal light is distorted by dispersion and nonlinear effects in the optical fiber transmission line 30, or waveform degradation occurs because of the accumulation of ASE noise in the optical amplifiers during [repeatered] repeated transmission. with the configuration of each optical repeater 32 shown in FIG. 6, the 3R functions can be obtained according to the present invention. Accordingly, by repeating these functions, long-haul transmission can be effected.

IN THE CLAIMS:

Please CANCEL claims 4 and 5.

Please AMEND claims 1, 8, 14,15 and 17 as follows (for the Examiner's convenience, all pending claims are reproduced below):

1. (ONCE AMENDED) An optical device comprising:

an optical path provided between an input port to which signal light modulated at a frequency f_s is supplied and an output port; and

an optical loop optically coupled to said optical path;

said optical loop [comprising:] <u>including:</u>

an optical amplifier for compensating for a loss in said optical loop so that laser oscillation occurs in said optical loop;

an adjuster for adjusting an optical path length of said optical loop so that said frequency f_s becomes equal to an integral multiple of the reciprocal of a recirculation period of said optical loop; and

a nonlinear optical medium for mode-locking said laser oscillation according to said signal light<u>,</u>

<u>wherein said nonlinear optical medium includes an optical fiber, and amplitude modulation is performed in said nonlinear optical medium by four-wave mixing using said signal light as pump light</u>.

2. (UNAMENDED) An optical device according to claim 1, wherein said optical loop further comprises an optical bandpass filter having a passband including the wavelength of said laser oscillation.

3. (UNAMENDED) An optical device according to claim 1, further comprising an optically coupler for optical coupling said optical path and said optical loop, said optical coupler providing a part of said optical path and a part of said optical loop.

6. (UNAMENDED) An optical device according to claim 1, wherein said nonlinear optical medium comprises a single-mode fiber.

7. (UNAMENDED) An optical device according to claim 1, wherein said nonlinear

optical medium comprises a highly nonlinear dispersion shifted fiber.

8. (TWICE AMENDED) An optical device according to claim [14] 6, wherein said nonlinear optical medium has a zero dispersion wavelength substantially equal to the wavelength of said signal light.

9. (UNAMENDED) An optical device according to claim 1, further comprising an input optical amplifier optically connected to said input port for amplifying said signal light.

10. (UNAMENDED) An optical device according to claim 9, further comprising an optical bandpass filter optically connected between said input port and said input optical amplifier and having a passband including a wavelength of said signal light.

11. (UNAMENDED) An optical device according to claim 1, further comprising an optical bandpass filter optically connected to said output port and having a passband including a wavelength of light obtained by said laser oscillation.

12. (UNAMENDED) An optical device according to claim 1, further comprising a waveform shaper optically connected to said output port for performing waveform shaping of said signal light according to an optical clock output from said output port.

13. (UNAMENDED) An optical device according to claim 12, wherein said waveform shaper comprises a nonlinear optical loop mirror.

14. (ONCE AMENDED) A system comprising:

an optical fiber transmission line for transmitting signal light modulated at a frequency f_s; and

an optical device connected to an output end of said optical fiber transmission line;

said optical device [comprising:] including:

an optical path provided between an input port to which said signal light is supplied and an output port; and

an optical loop optically coupled to said optical path;

said optical loop [comprising:] including:

an optical amplifier for compensating for a loss in said optical loop so that laser oscillation occurs in said optical loop;

an adjuster for adjusting the optical path length of said optical loop so that said frequency f_s becomes equal to an integral multiple of the reciprocal of a recirculation period of said optical loop; and

a nonlinear optical medium for mode-locking said laser oscillation according to said signal light,

wherein said nonlinear optical medium includes an optical fiber, and amplitude modulation is performed in said nonlinear optical medium by four-wave mixing using said signal light as pump light.

15. (ONCE AMENDED) A system comprising:

an optical fiber transmission line for transmitting signal light; and

at least one optical repeater arranged along said optical fiber transmission line;

each of said at least one optical repeater [comprising:] including:

an optical clock regenerator for regenerating an optical clock by mode locking of laser oscillation according to said signal light; and

a waveform shaper for performing waveform shaping of said signal light according to said optical clock regenerated by said optical clock regenerator,

said optical clock regenerator including:

an optical path provided between an input port to which signal light modulated at a frequency f_s is supplied and an output port; and

an optical loop optically coupled to said optical path;

said optical loop including:

an optical amplifier for compensating for a loss in said optical loop so that laser oscillation occurs in said optical loop;

an adjuster for adjusting an optical path length of said optical loop so that said frequency f_s becomes equal to an integral multiple of the reciprocal of a recirculation period of said optical loop; and

a nonlinear optical medium for mode-locking said laser oscillation according to said signal light,

wherein said nonlinear optical medium includes an optical fiber, and amplitude modulation is performed in said nonlinear optical medium by four-wave mixing using said signal

<u>light as pump light.</u>

16. (UNAMENDED) A system according to claim 15, wherein said waveform shaper comprises a nonlinear optical loop mirror.

17. (ONCE AMENDED) A method comprising the steps of:

(a) generating laser oscillation in an optical loop including <u>an optical fiber as</u> a nonlinear medium;

(b) introducing a signal light modulated at a frequency f_s into said optical loop;

(c) adjusting the optical path length of said optical loop so that said frequency f_s becomes equal to an integral multiple of the reciprocal of a recirculation period of said optical loop; and

(d) regenerating an optical clock by mode-locking said laser oscillation according to said signal light,

<u>wherein amplitude modulation is performed in said nonlinear optical medium by four-wave mixing using said signal light as pump light.</u>